

Aquarius radiometer and scatterometer weekly polar-gridded products to monitor ice sheets, sea ice, and frozen soil

Ludovic Brucker^{1,2}, Emmanuel Dinnat^{1,3}, and Lora Koenig¹

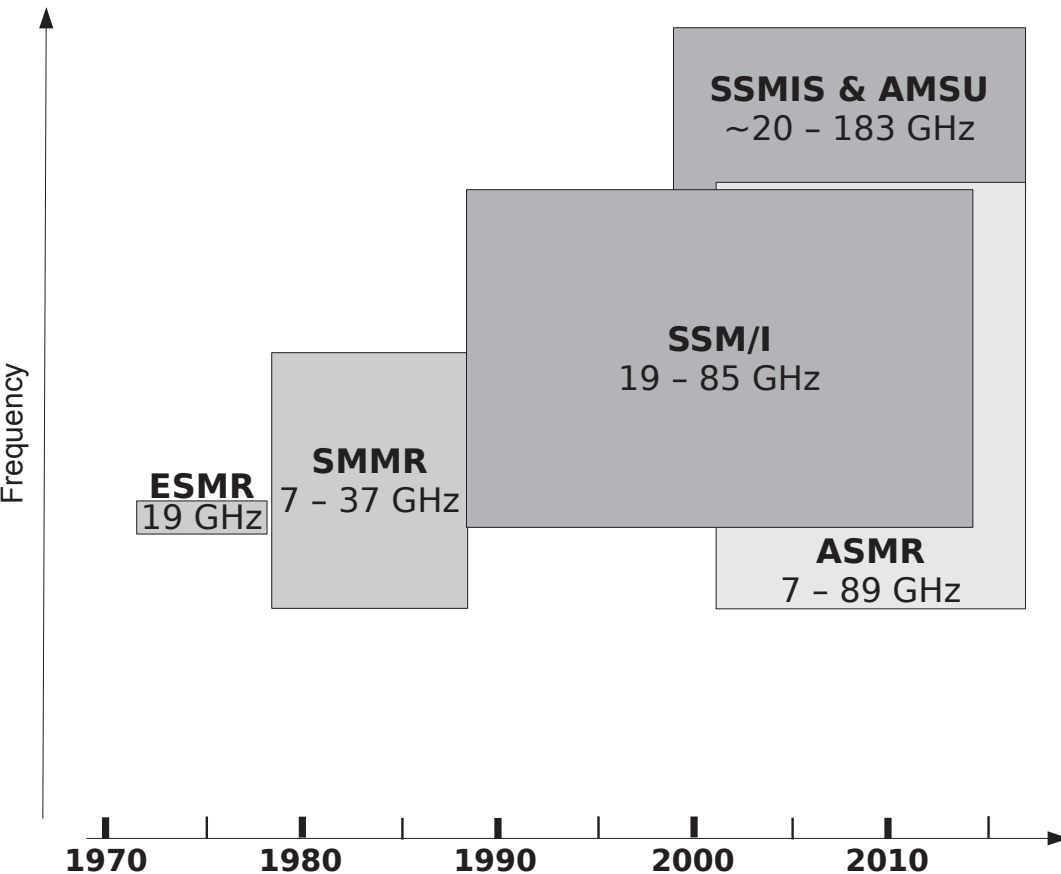
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³ Chapman University, School of Earth and Environmental Sciences, Orange, CA, USA

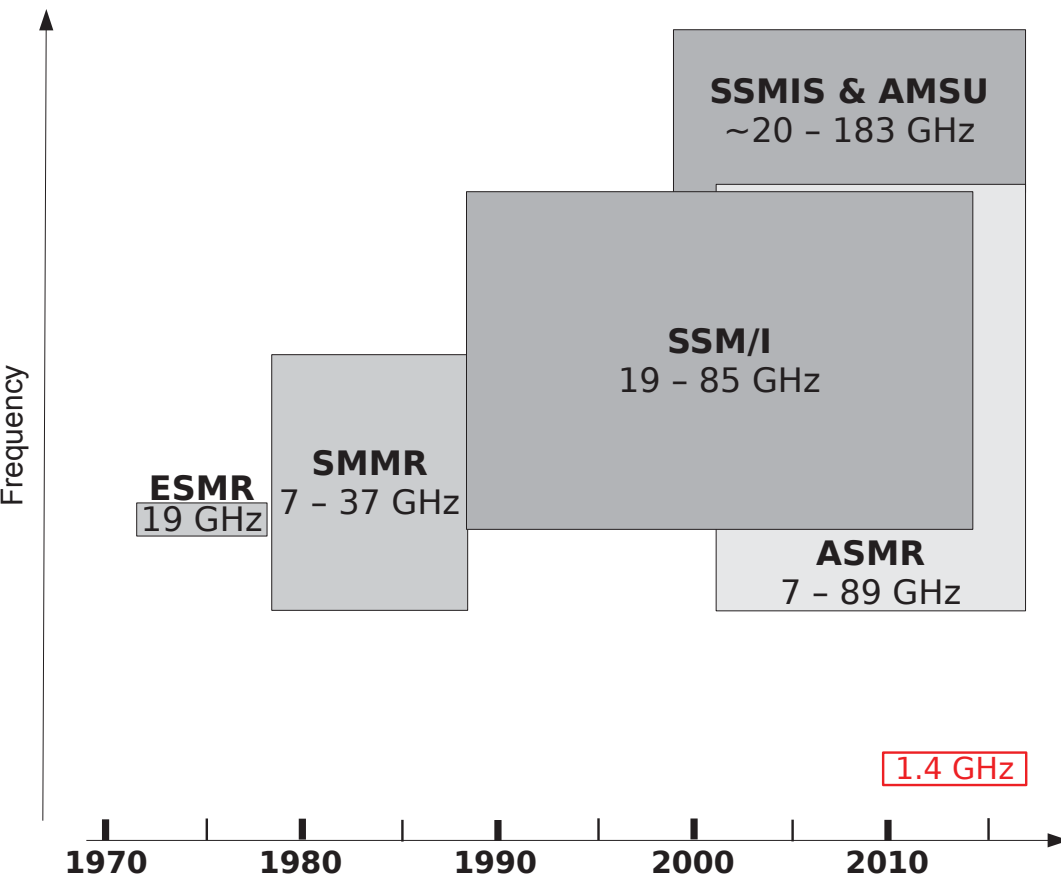


Microwave radiometers used to monitor the cryosphere



Used for sea ice concentration
snow accumulation
snow melt extent & duration
glaciological properties
(grain size, stratification, ...)

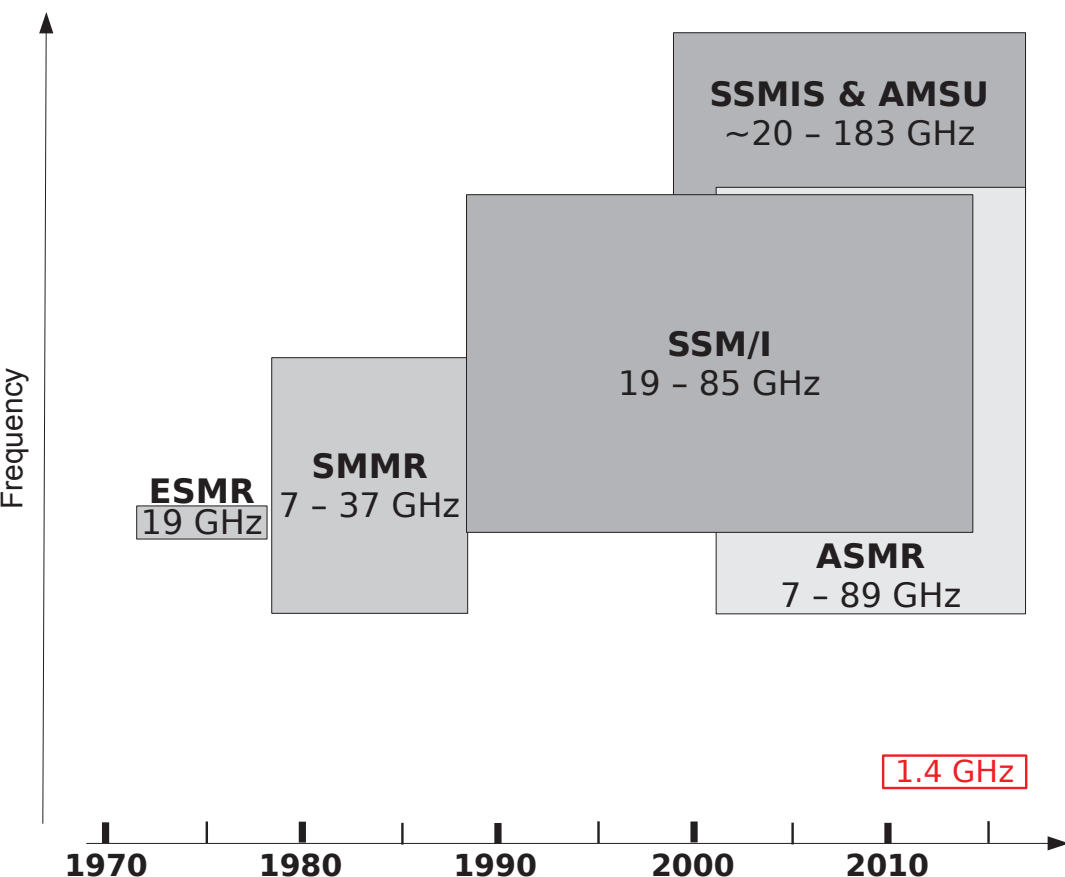
Microwave radiometers used to monitor the cryosphere



Used for thin sea ice thickness
soil freeze/thaw physical state
ice sheet temperature
...

L-band observations

Microwave radiometers used to monitor the cryosphere



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L-band observations SMOS (ESA) launched in November 2009
Aquarius (NASA/CONAE) launched in June 2011
SMAP (NASA) launch scheduled November 2014

The current 1.4 GHz (L-band) space-borne radiometers

Aquarius

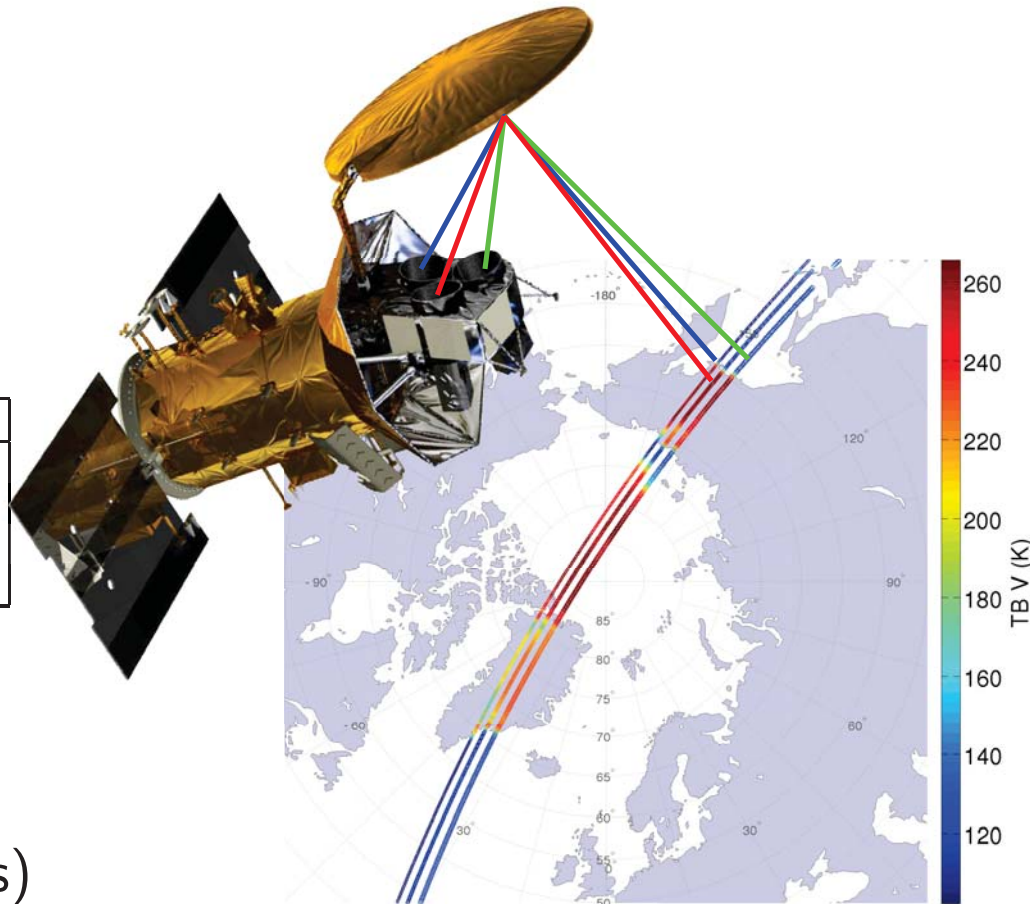
Designed for sea surface salinity retrievals

Operates **3** non-scanning radiometers

Radiometer	1	2	3
Incidence angle ($^{\circ}$)	29.2	38.4	46.3
Footprint size (km \times km)	76 \times 94	84 \times 120	97 \times 156
Northernmost latitude ($^{\circ}$)	84.99	86.07	87.40
Southernmost latitude ($^{\circ}$)	79.01	77.90	76.54

Large footprint sizes, but
Excellent sensitivity of **0.2 K**

Operates a scatterometer (same feed horns)



The current 1.4 GHz (L-band) space-borne radiometers

Aquarius

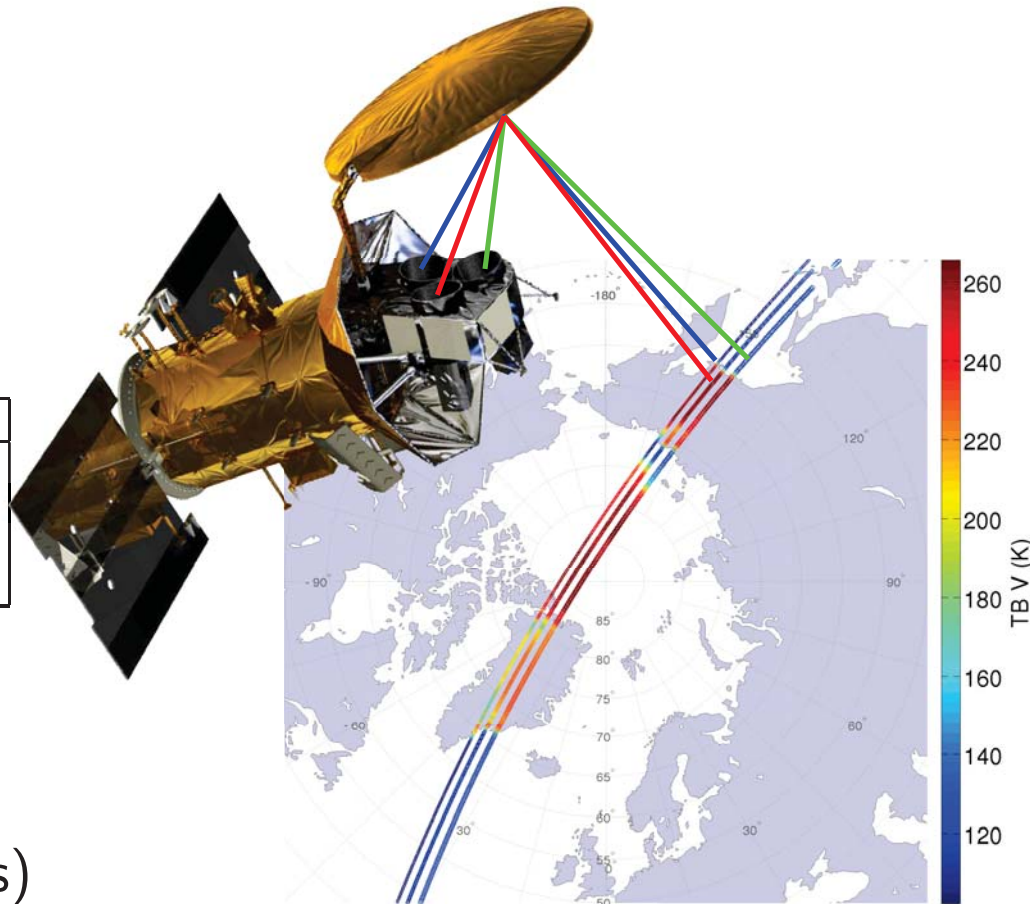
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Only swath observations available

Outline

1. Introduction to new Aquarius weekly polar-gridded products
2. Brightness temperature observations over the ice sheets
3. Active & passive observations over subarctic land
4. Salinity retrievals – impact of sea ice
5. Conclusion

New Aquarius weekly polar-gridded products

Input data sets: Aquarius Level 2 swath data (PO.DAAC, version 3.0)
Spatial coverage: latitudes $>50^\circ$
Temporal resolution: 7 days
Grid cell size: 36 km \times 36 km
Grid: Equal-Area Scalable Earth (EASE2.0) grid (*Brodzik et al., 2012*)
(constant resolution in polar regions, consistent with SMAP)

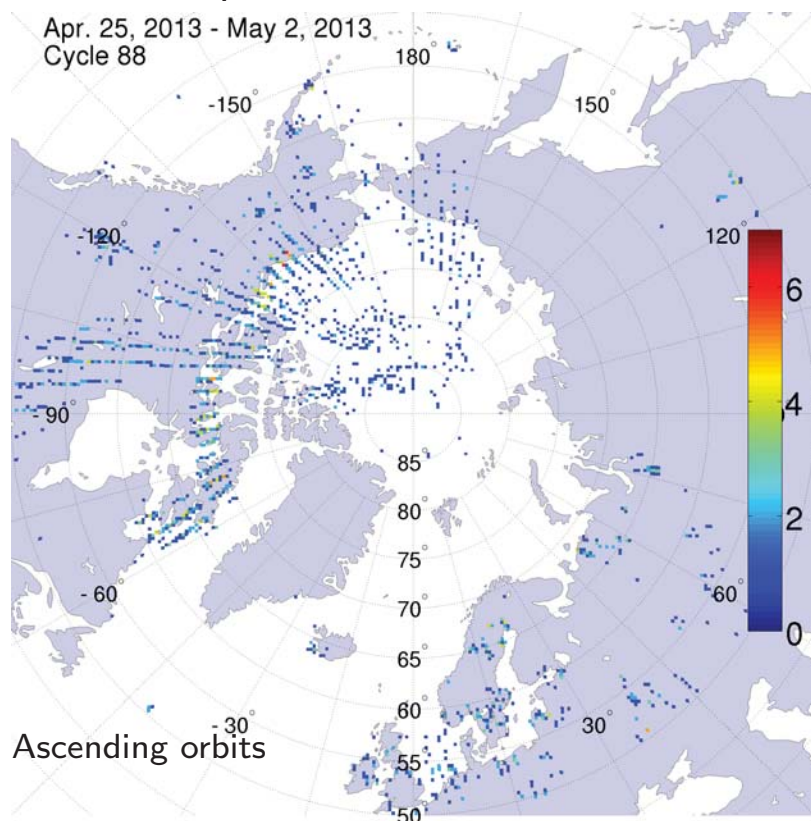
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RFI

New Aquarius weekly polar-gridded products

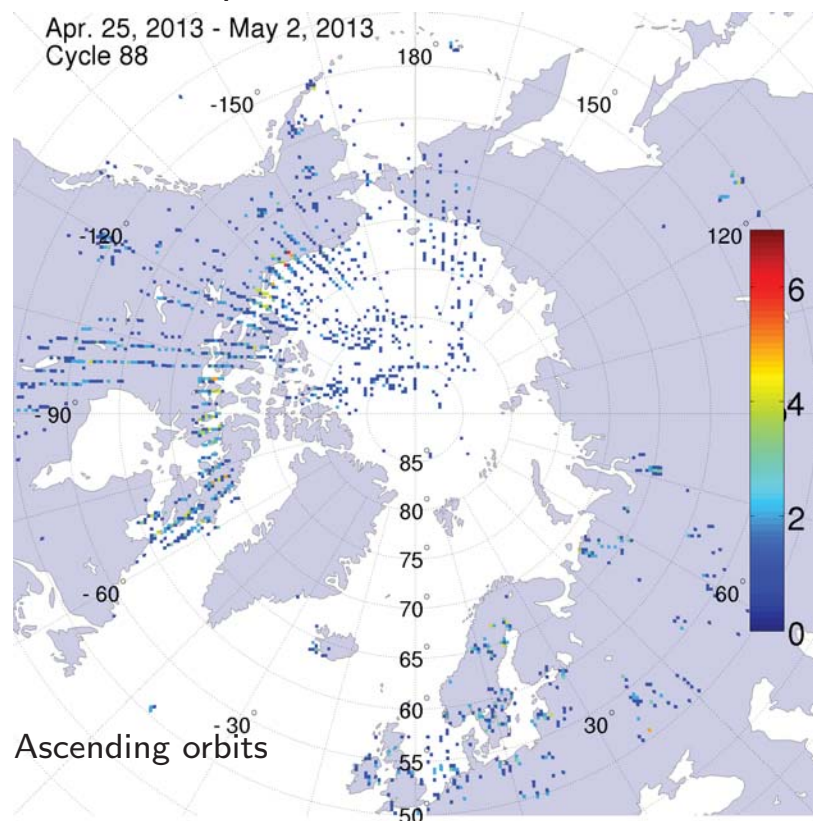
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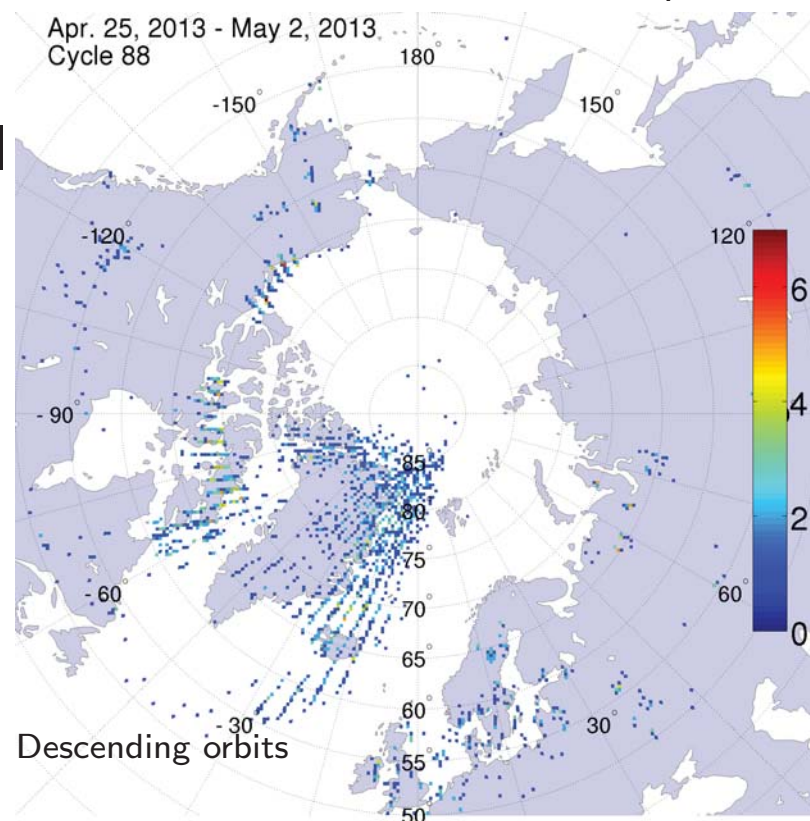
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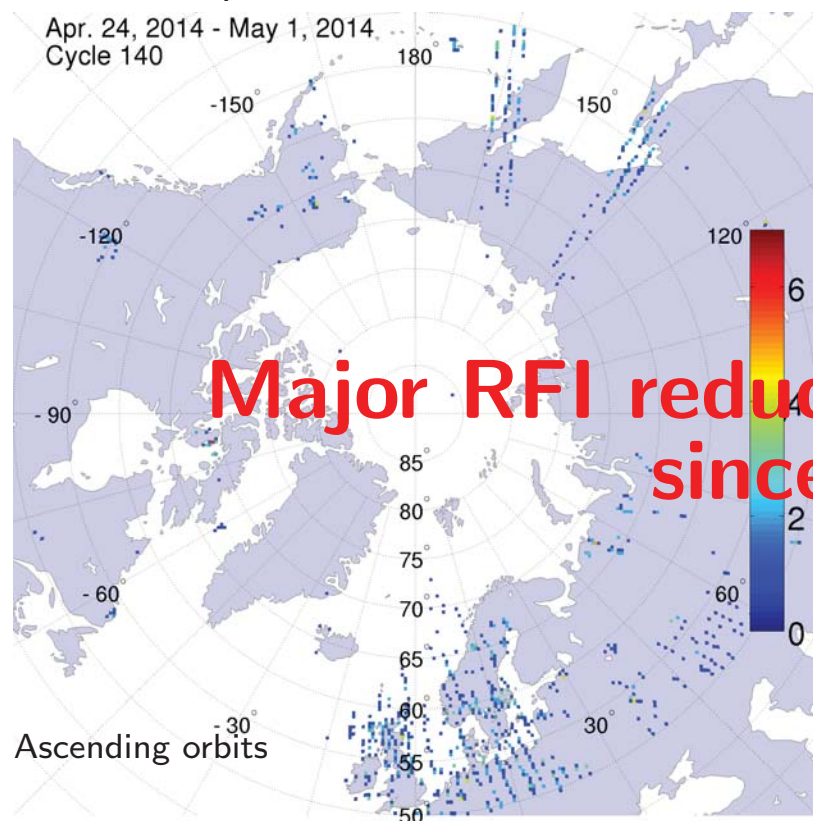


RFI

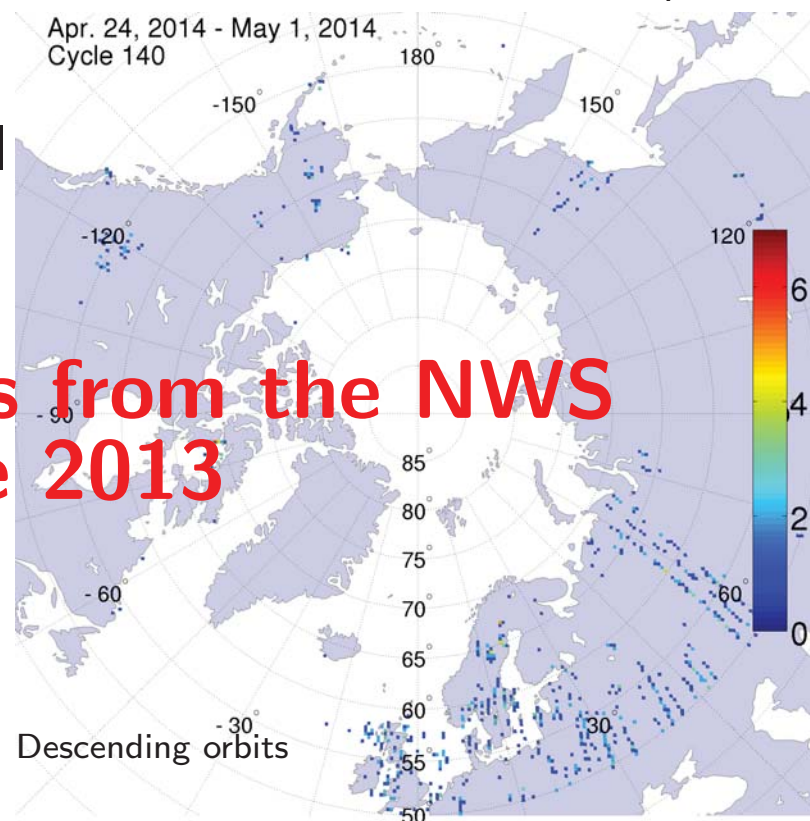


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RFI



New Aquarius weekly polar-gridded products

Observations of brightness temperature (TB)

Observations of normalized radar cross section (NRCS)

Retrievals of sea surface salinity (SSS)

New Aquarius weekly polar-gridded products

Observations of brightness temperature (TB)
at V & H polarizations
for radiometers 1, 2, and 3 (separately)
for ascending orbits, descending orbits, and combined

Observations of normalized radar cross section (NRCS)

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Observations of normalized radar cross section (NRCS)
at VV, VH, & HH polarizations
for beams 1, 2, and 3 (separately)
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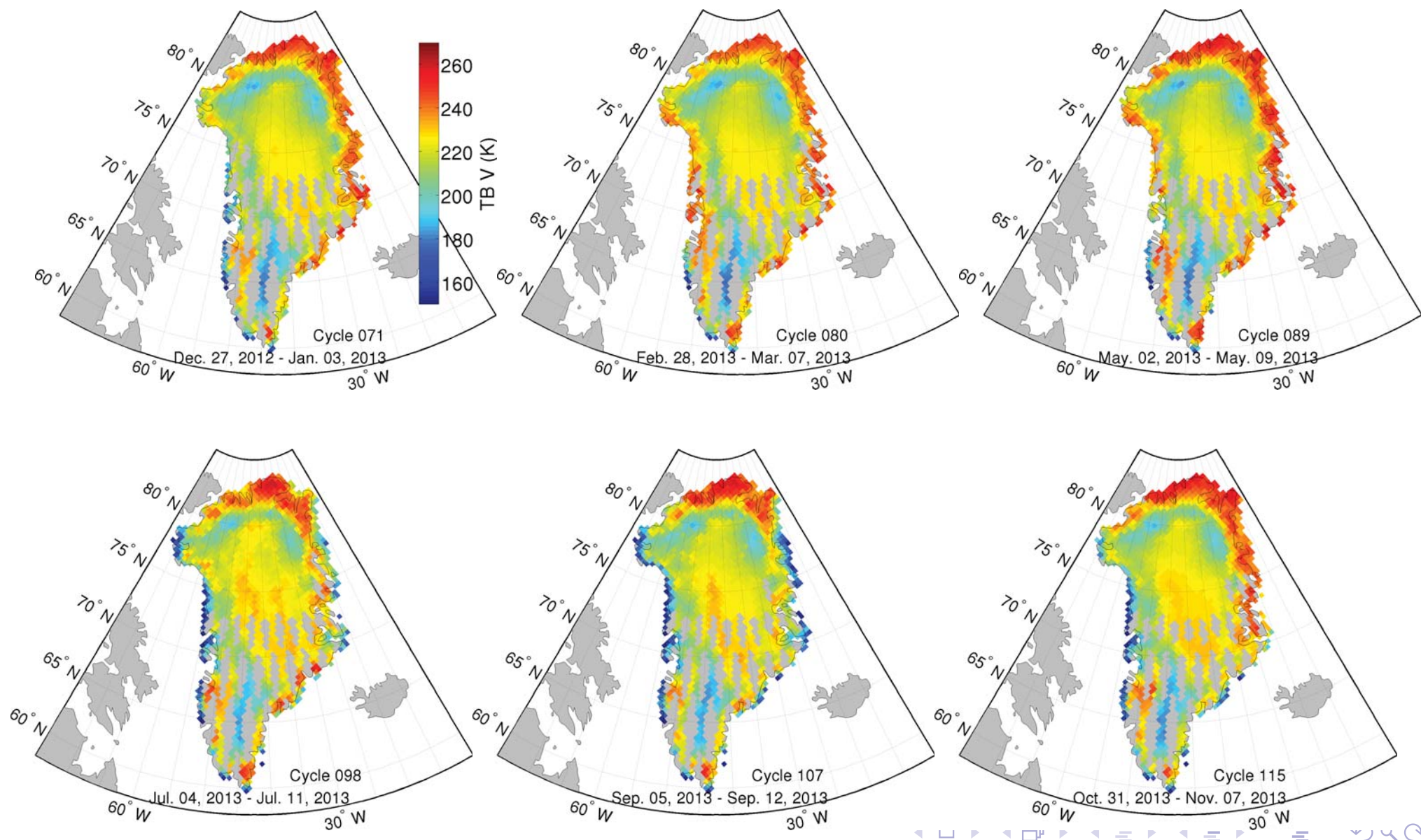
Weekly mean and stdev, number of observations, and ice fraction

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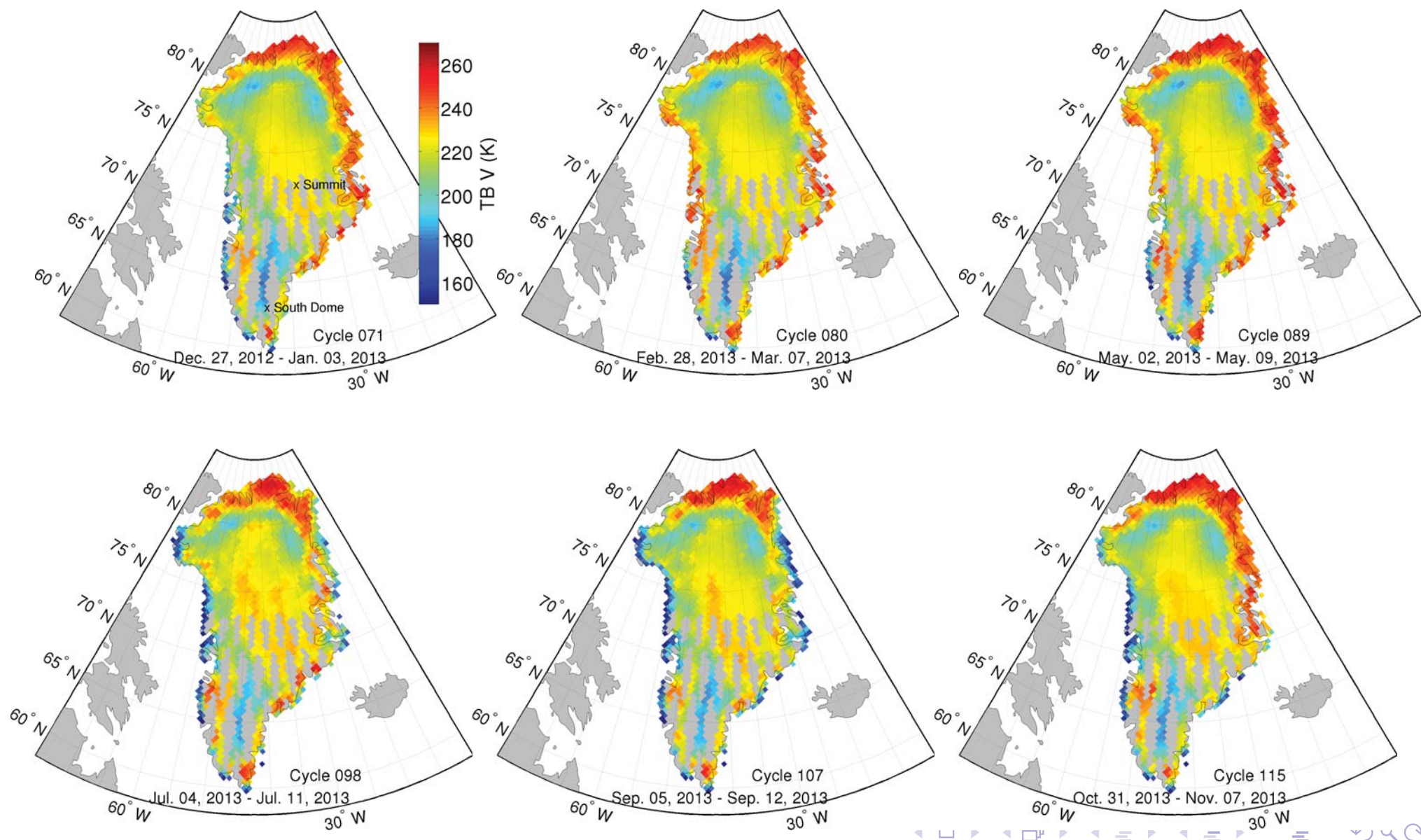
Greenland

Brightness temperature (radiometer 3 $\theta_{\text{inc}} \sim 46^\circ$, vertical polarization)



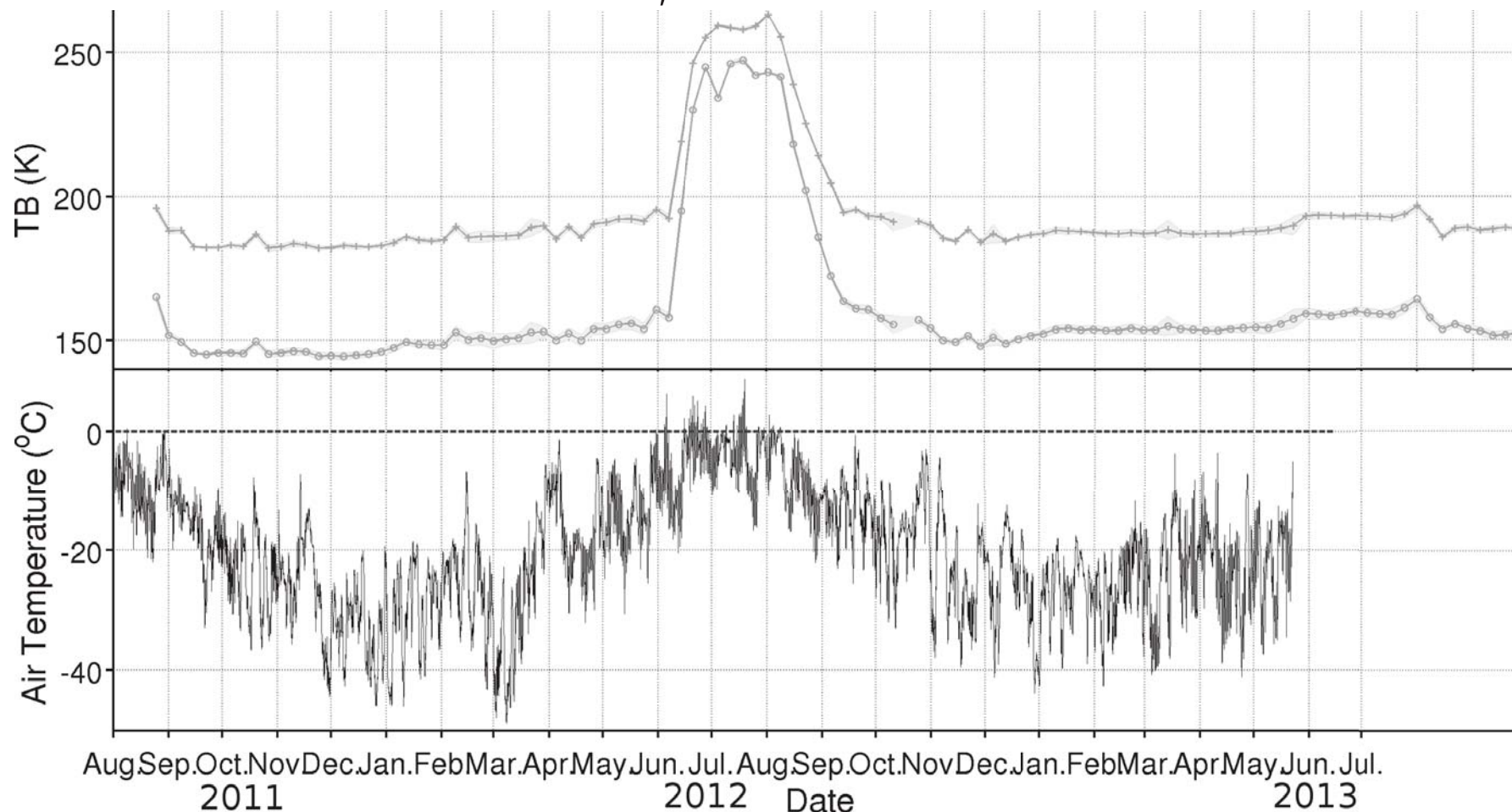
Greenland

Brightness temperature (radiometer 3 $\theta_{\text{inc}} \sim 46^\circ$, vertical polarization)



South Dome, Greenland

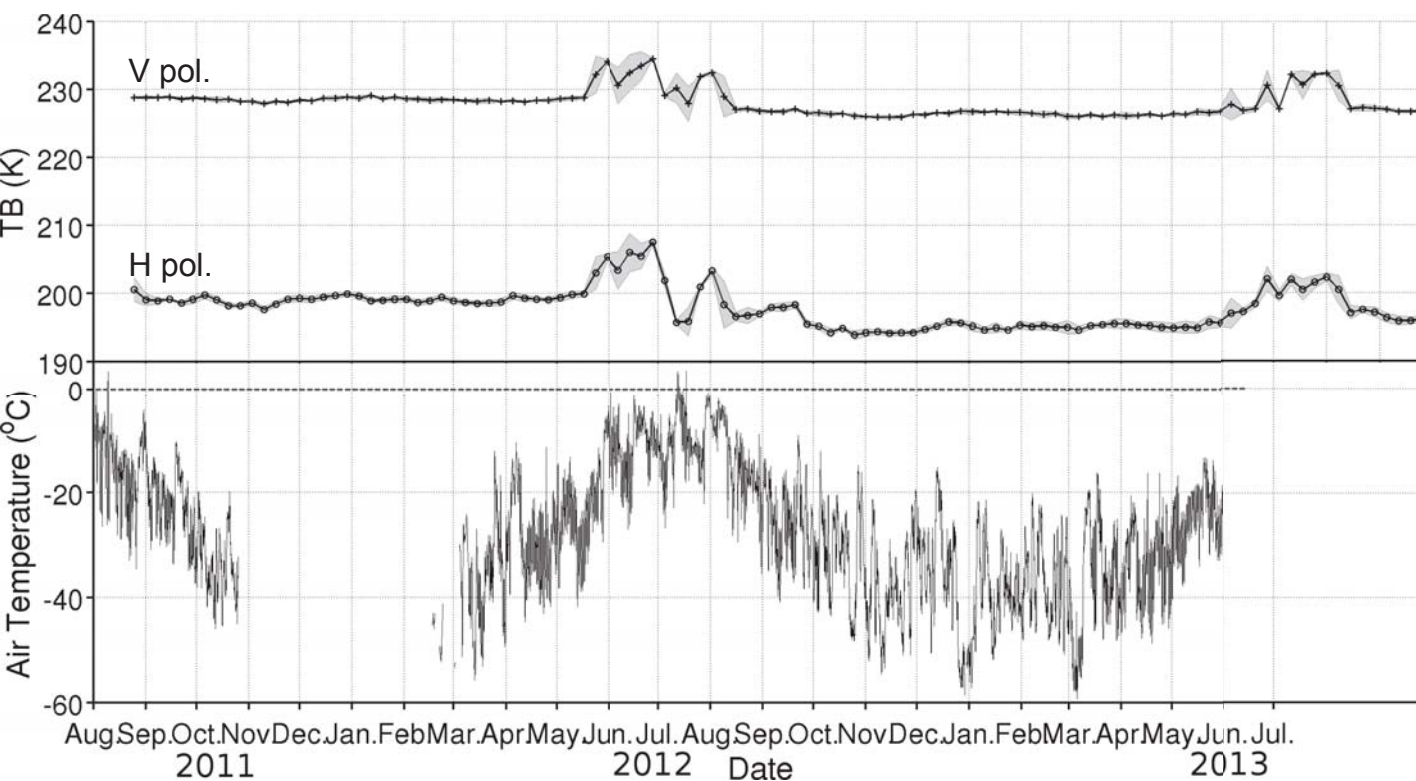
At South Dome, melt events are common



L-band TB shows . a typical passive microwave signal for melt events
 . a slight trend of increasing TB during the winter

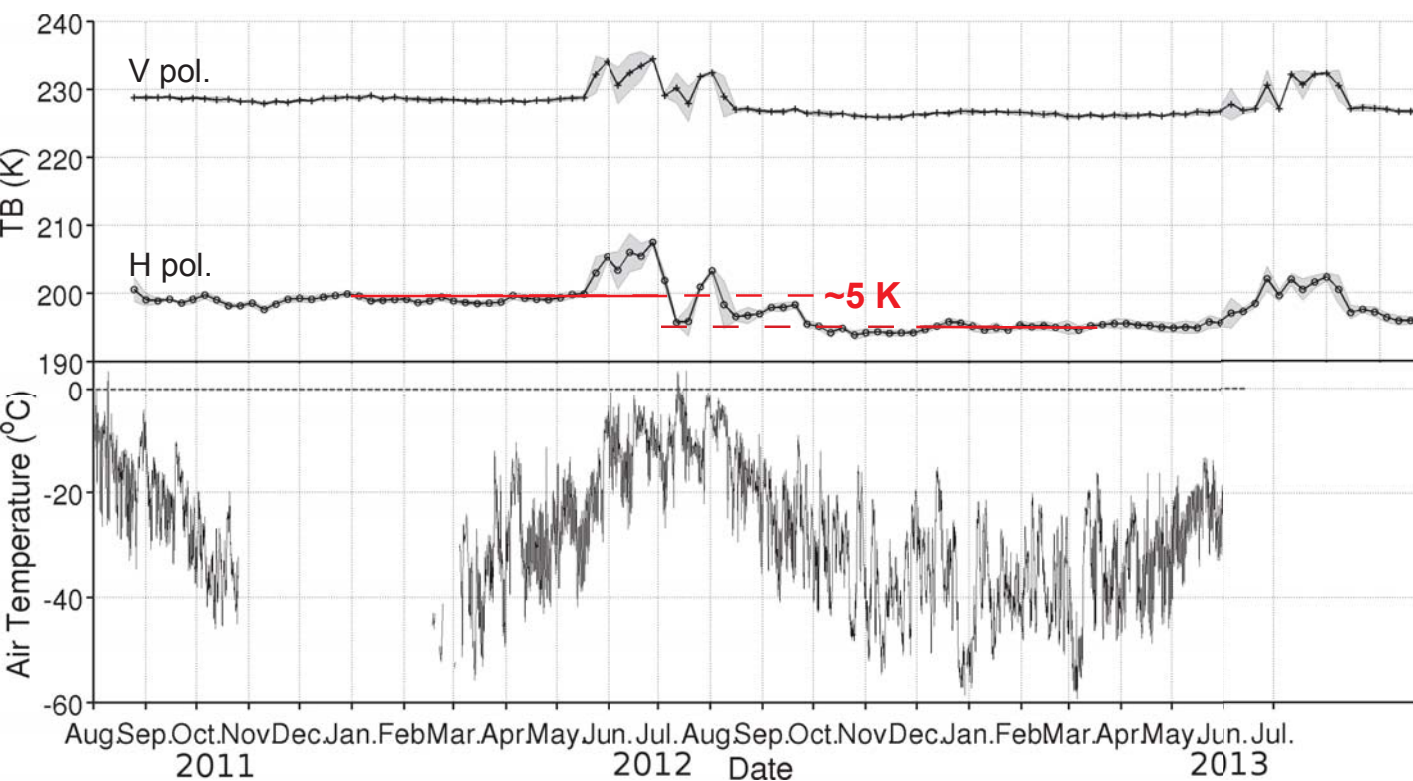
Summit, Greenland

At Summit, melt events are exceptional



Summit, Greenland

At Summit, melt events are exceptional

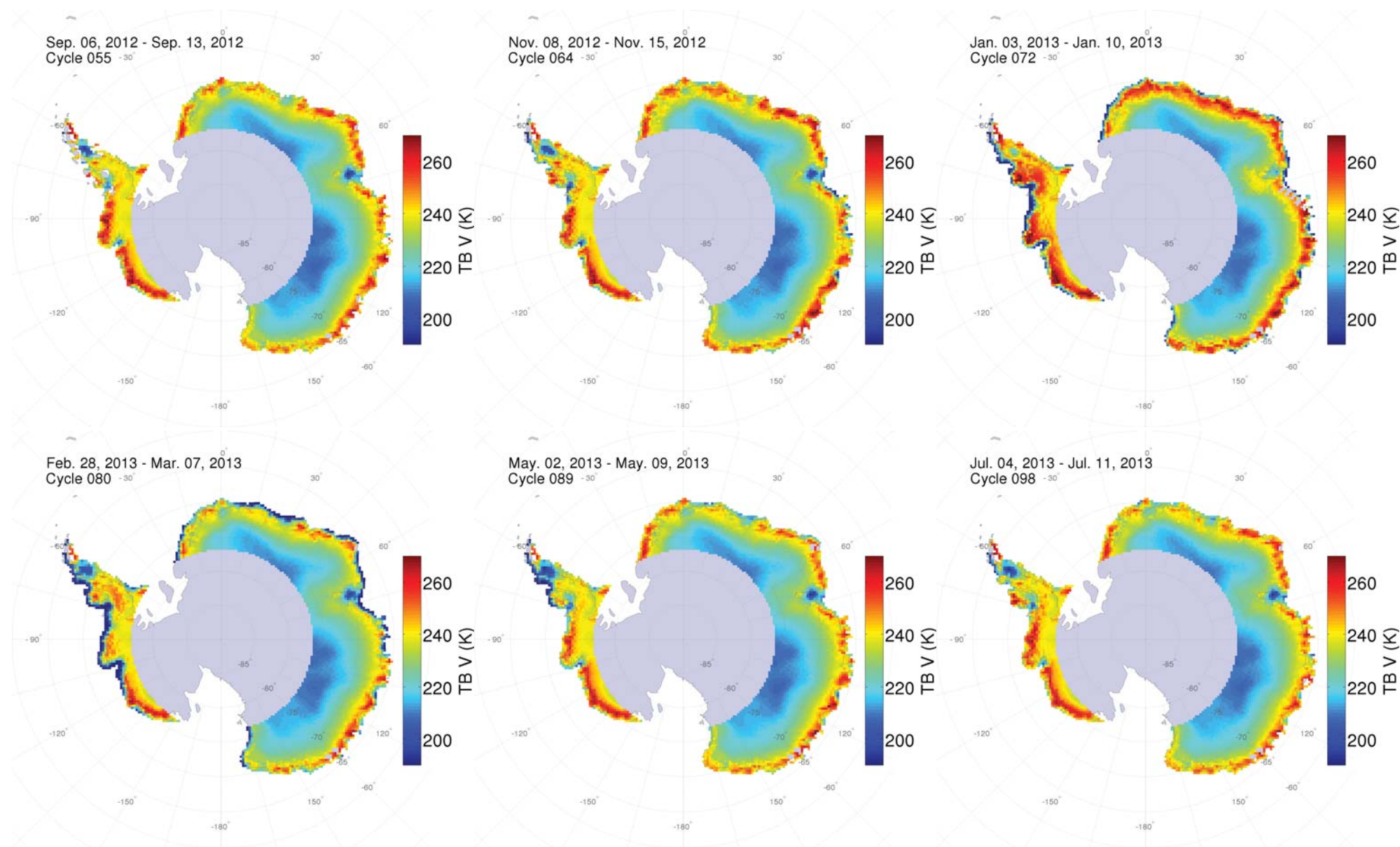


(Credit: Mary Albert; Nghiem et al., 2012)

Surface reflection is an important radiative transfer process even when the radiation has a large penetration depth

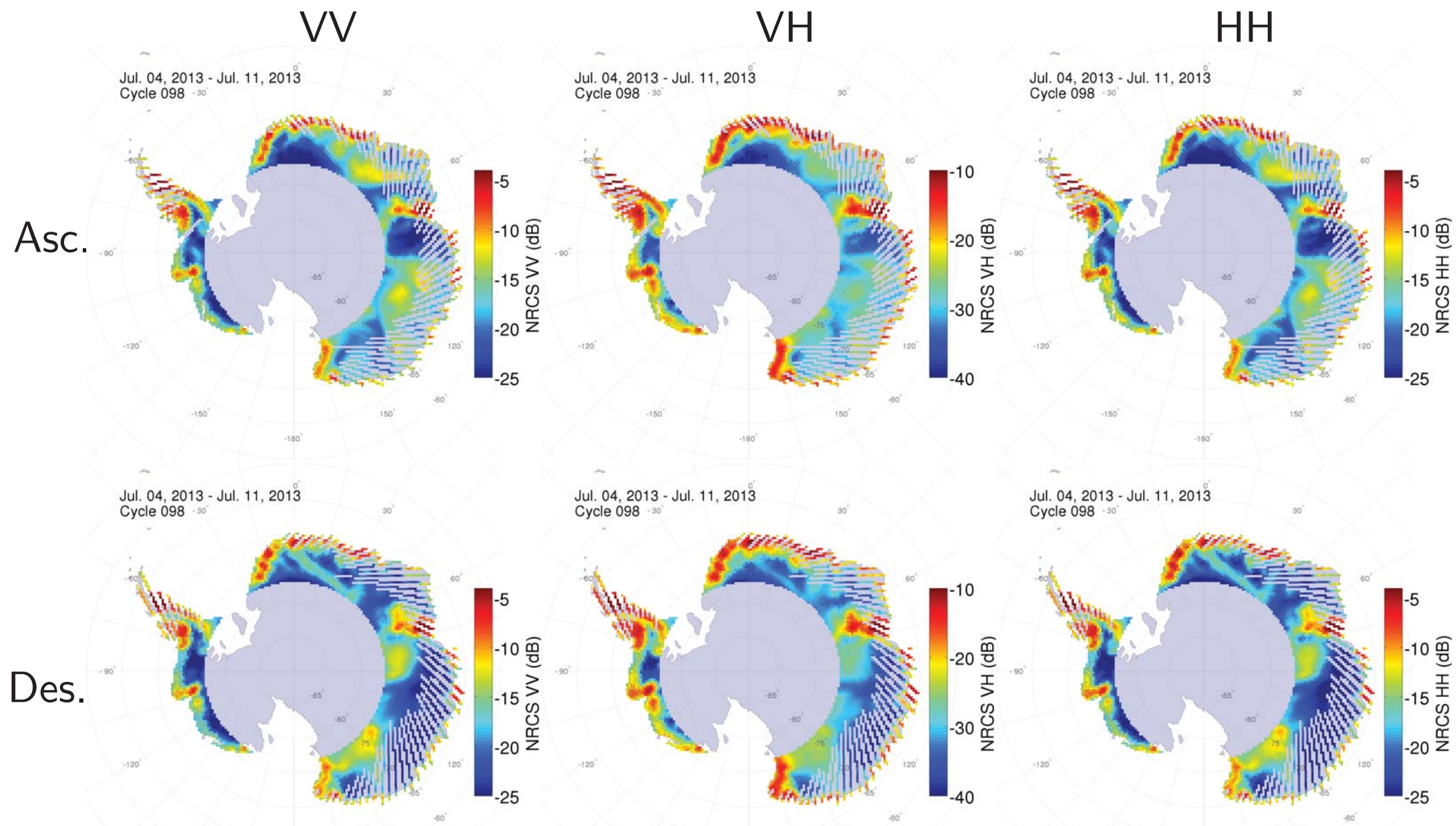
Antarctica

Brightness temperature (radiometer 3 $\theta_{\text{inc}} \sim 46^\circ$, vertical polarization)



Antarctica

Normalized radar cross section (NRCS, beam 3 $\theta_{\text{inc}} \sim 46^\circ$)

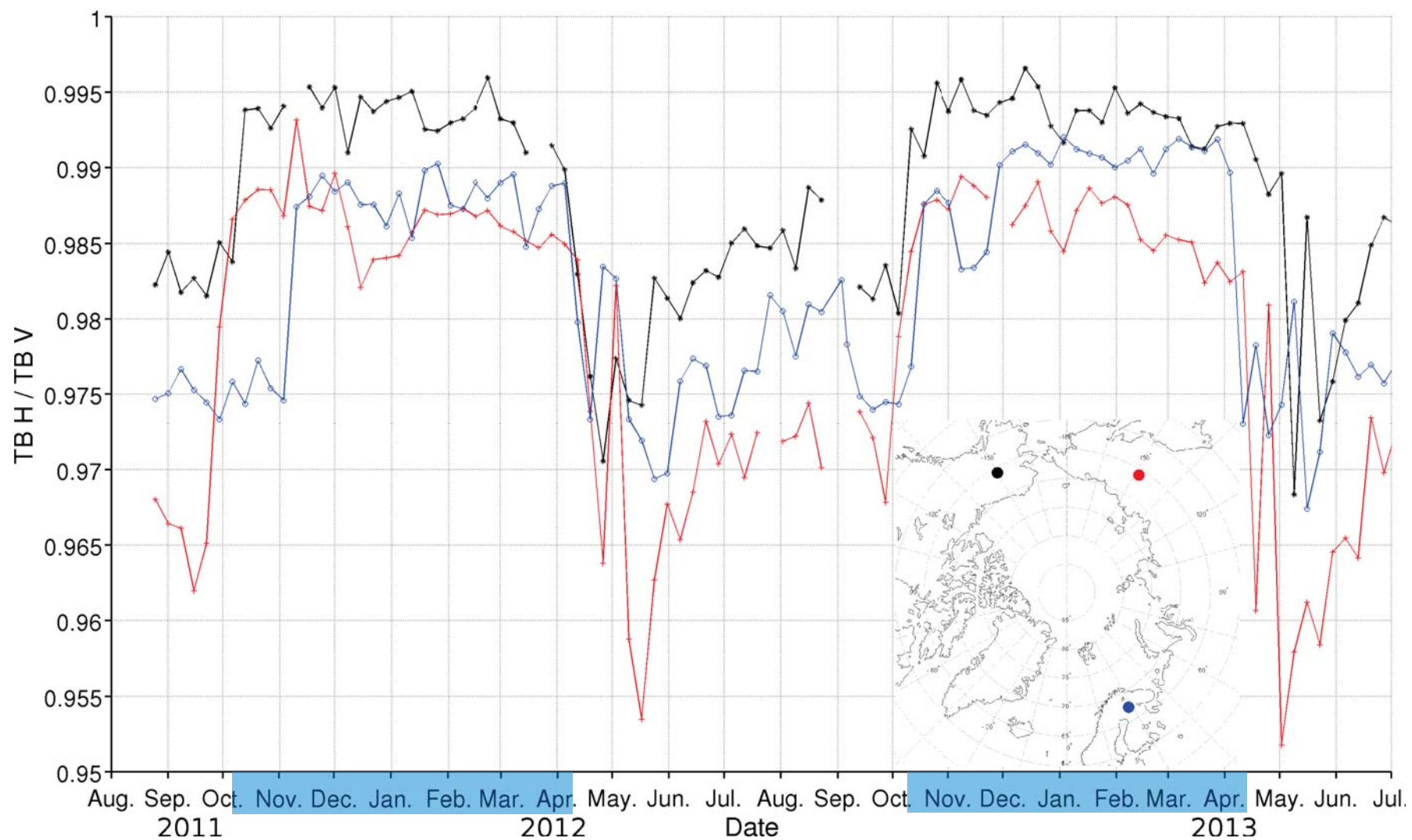


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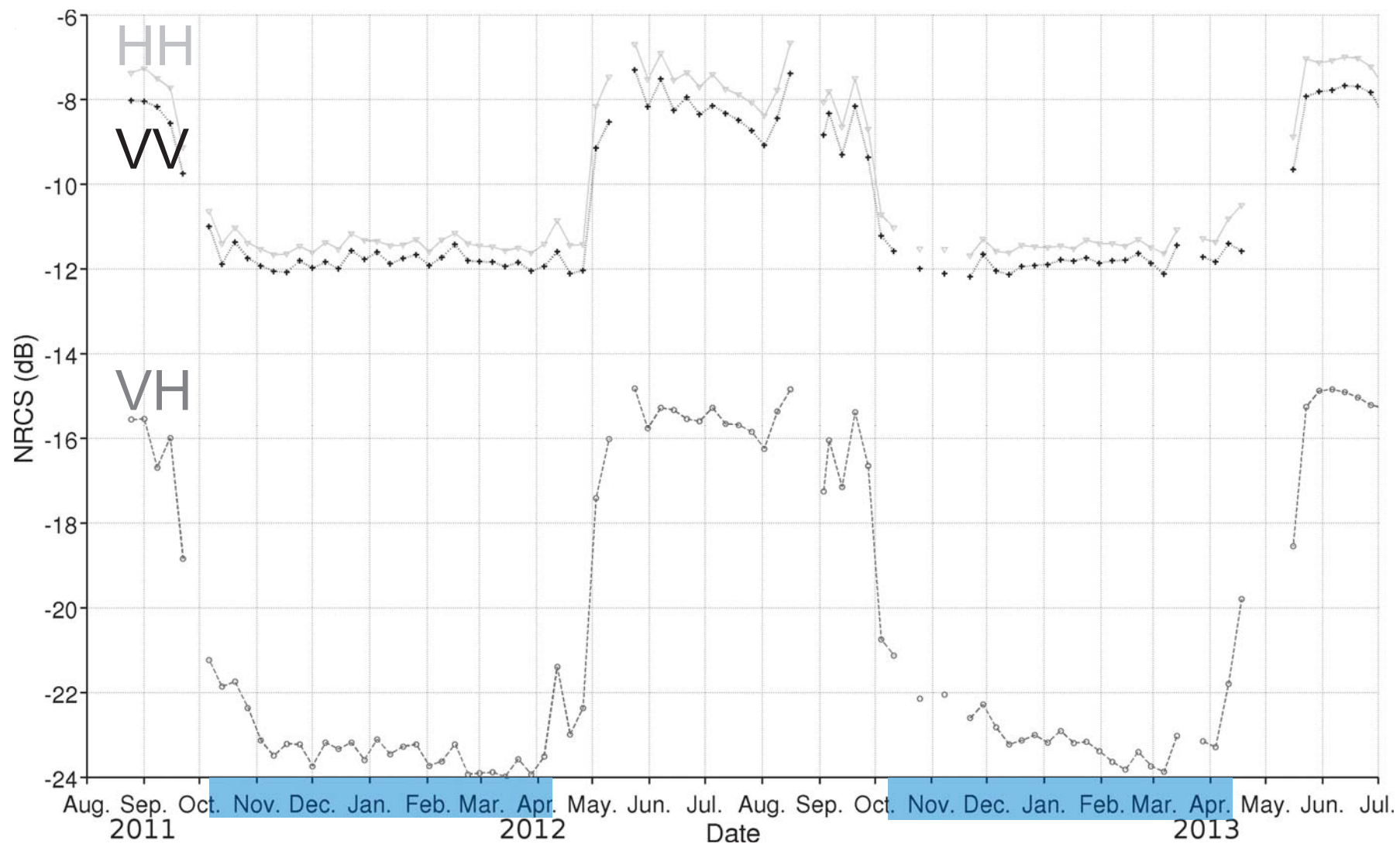
Frozen soil

Passive L-band observations (radiometer 1)



Frozen soil

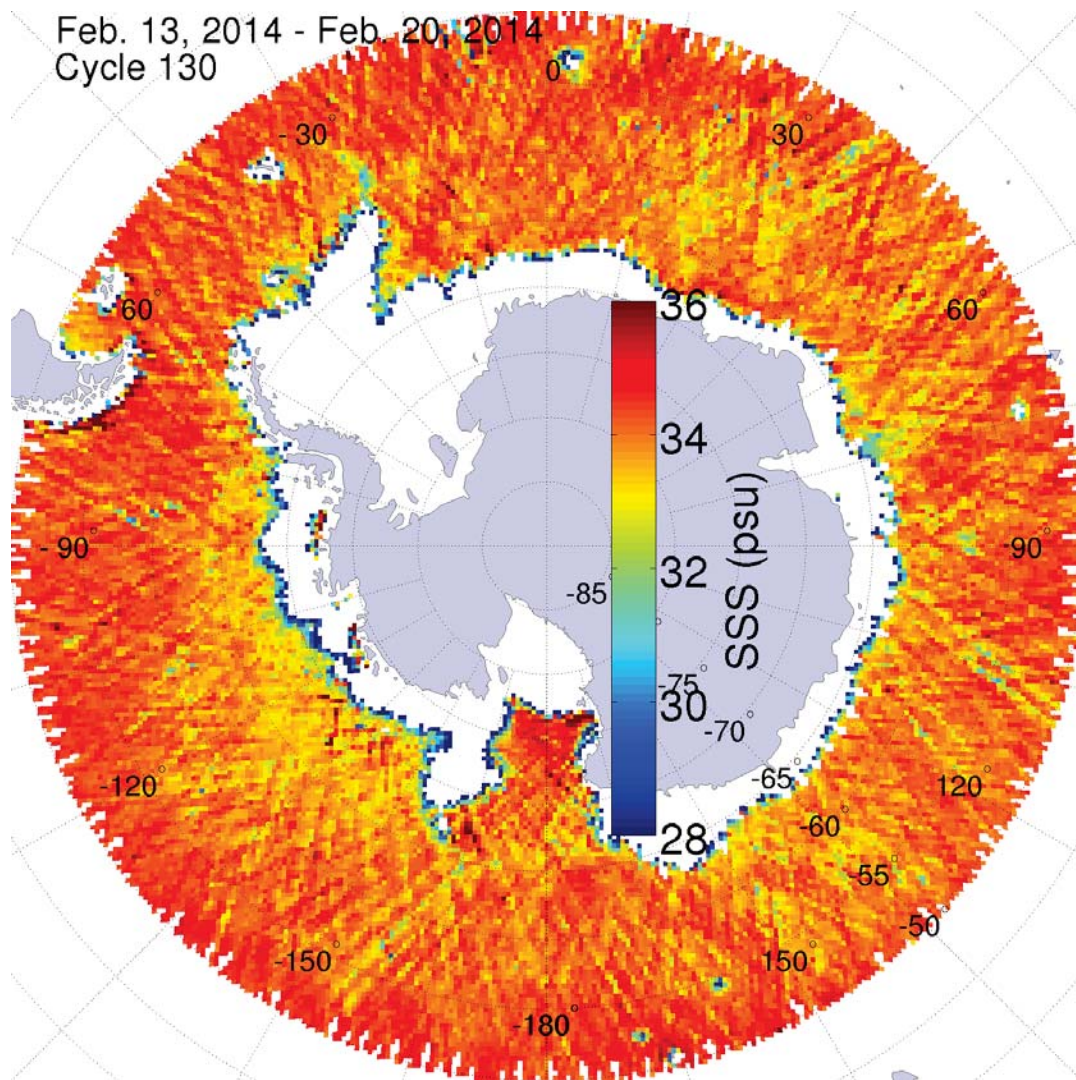
Active L-band observations (beam 1)



Outline

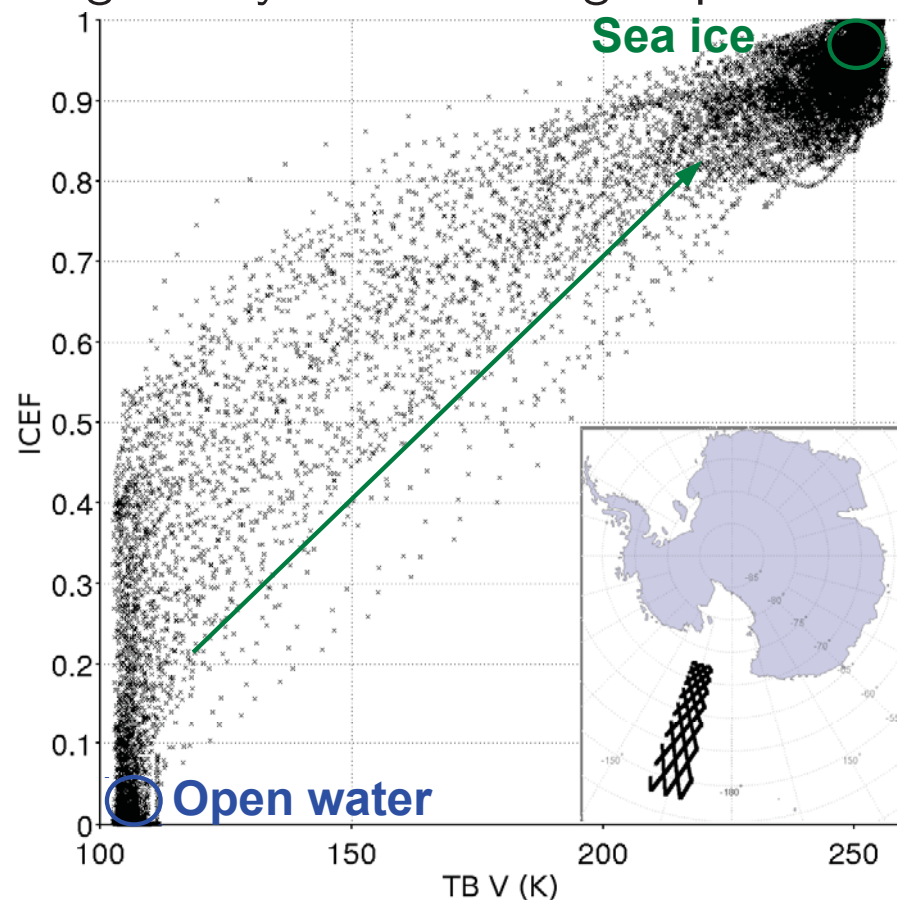
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Impact of sea ice on SSS retrievals



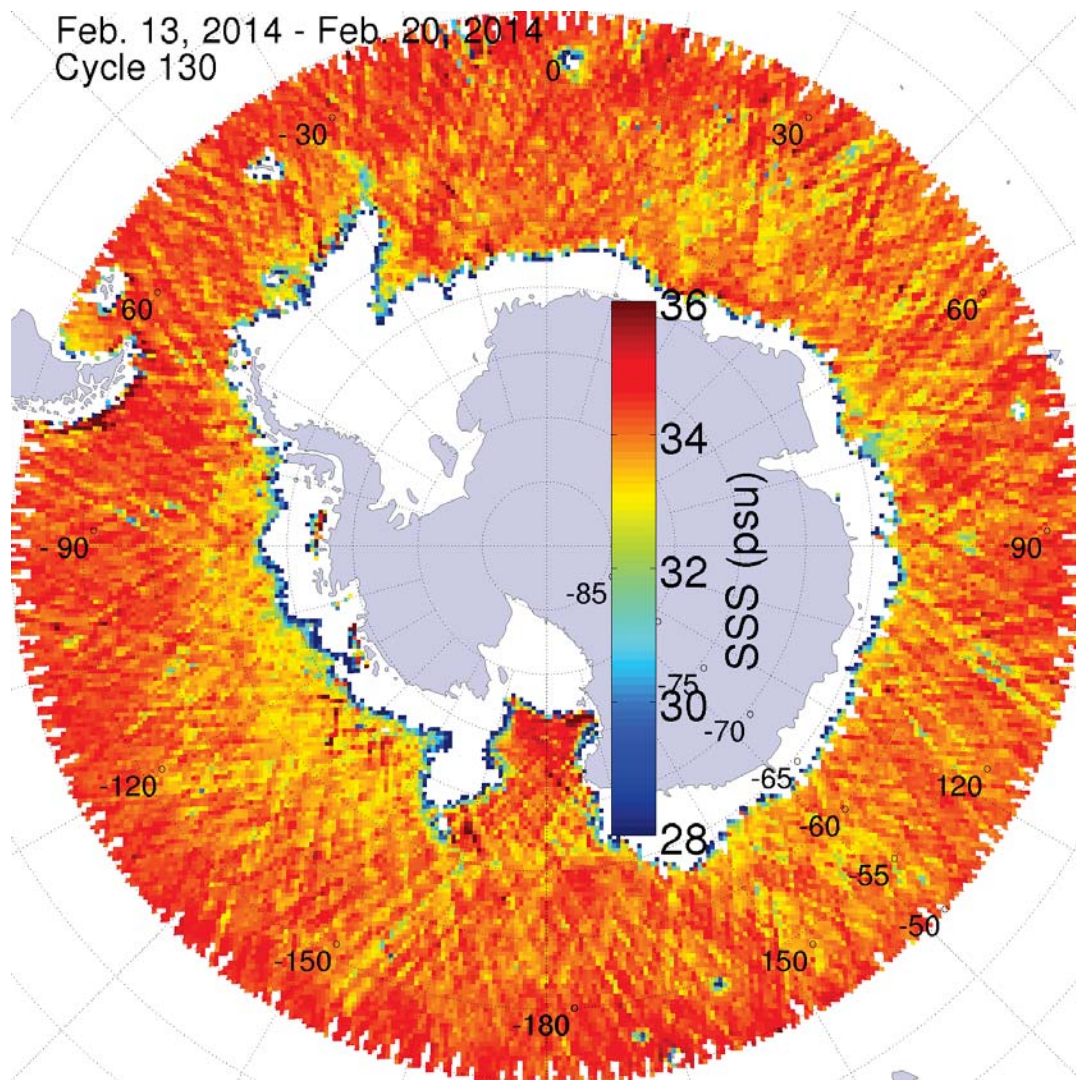
No salinity retrievals where sea ice exists

Aquarius' ice fraction refers to the NCEP retrieved sea ice conc. integrated over the sensor's field of view and weighted by the antenna gain patterns



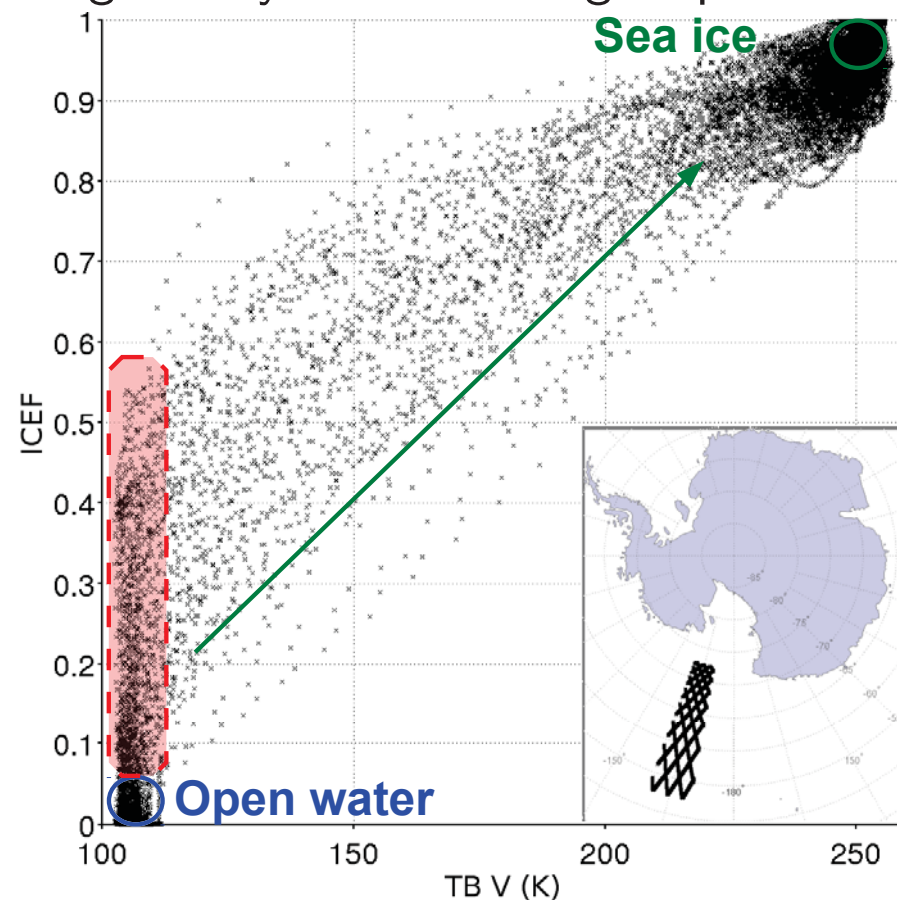
Strong sensitivity to sea ice

Impact of sea ice on SSS retrievals



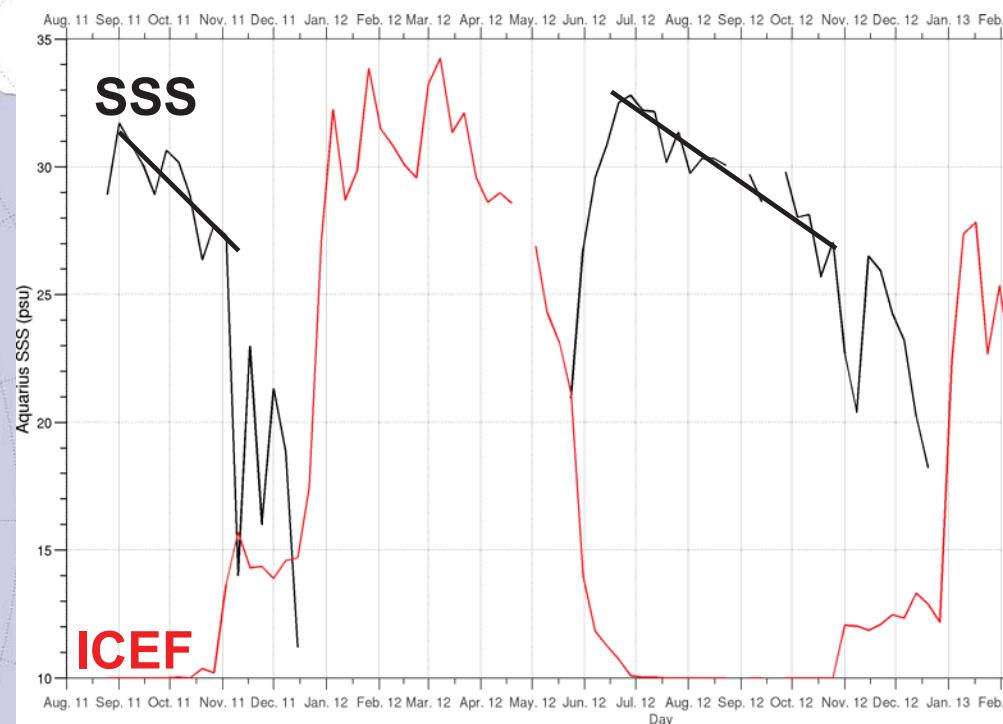
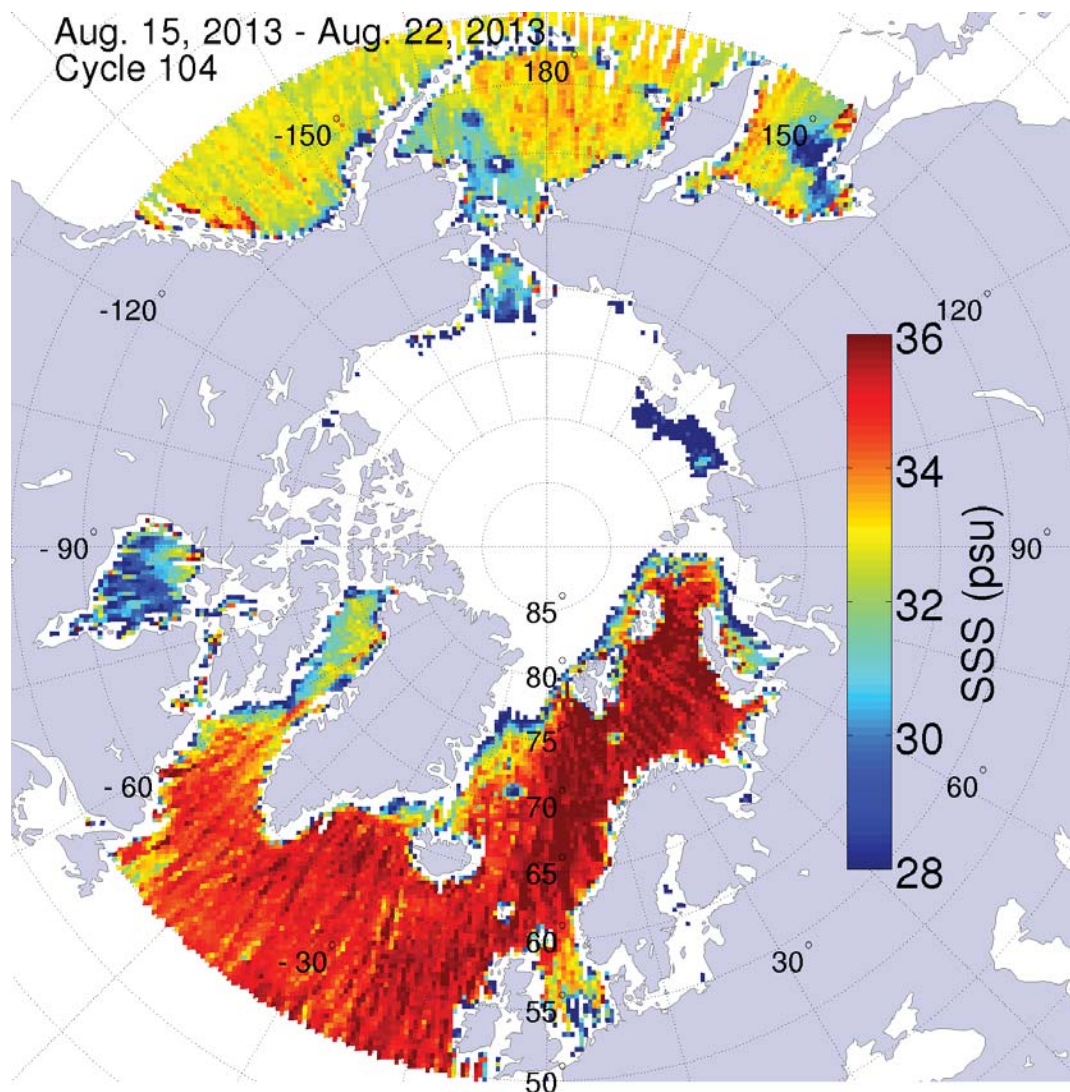
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Over-estimated sea ice conc.

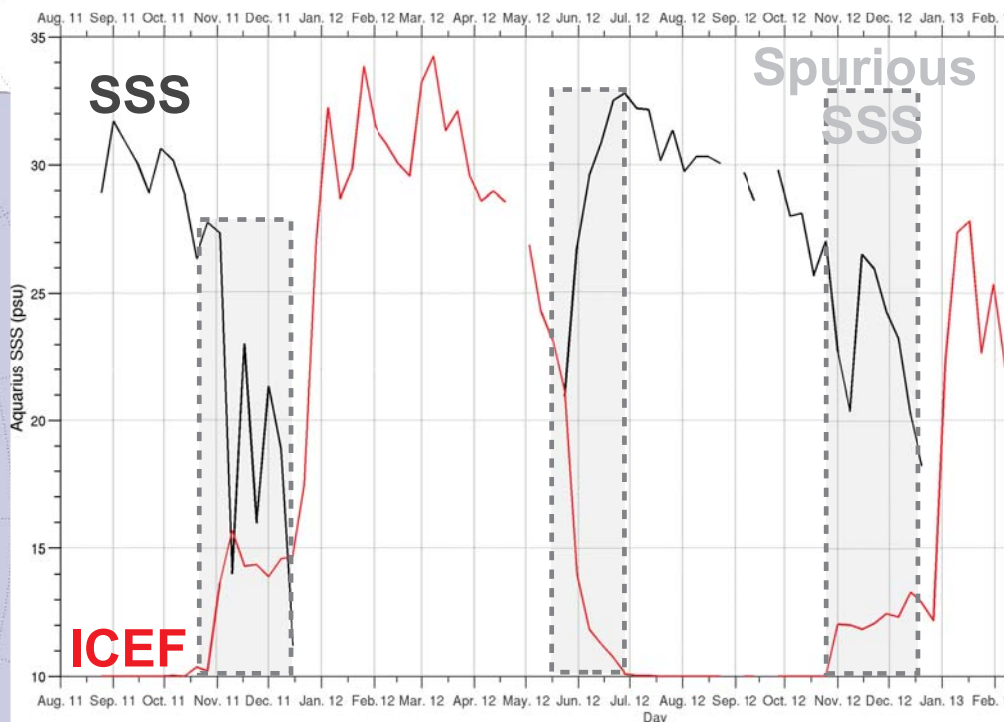
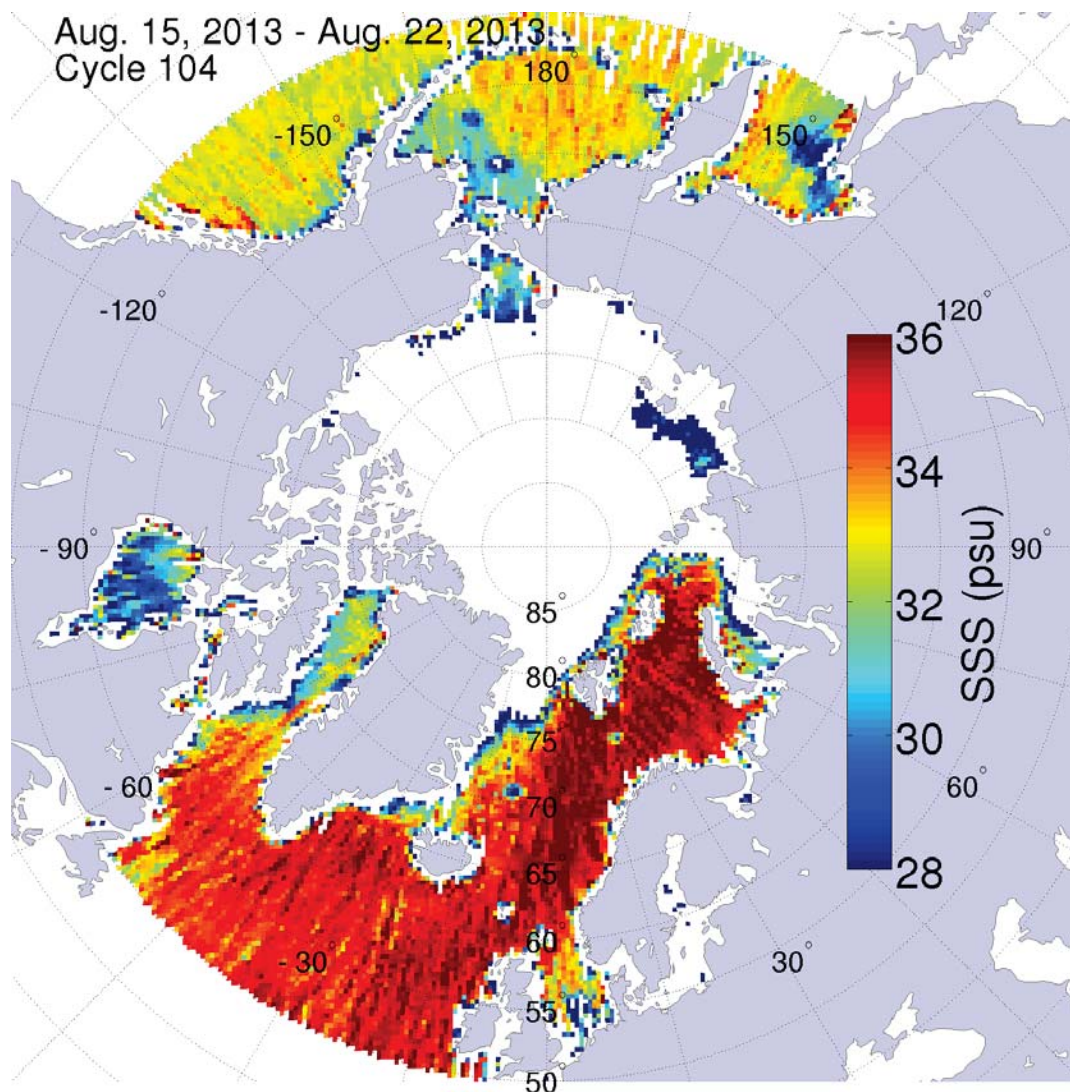
Impact of sea ice on SSS retrievals



Studying freshening resulting from ice sheet melt using Aquarius SSS retrievals requires improved sea ice emission model

No salinity retrievals where sea ice exists

Impact of sea ice on SSS retrievals



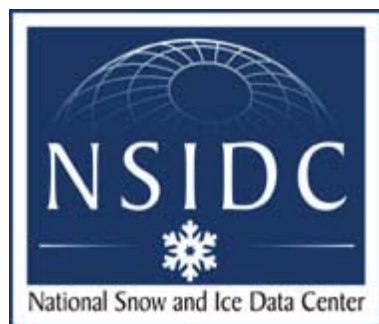
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Conclusion

3 weekly polar-gridded products are available with Aquarius:

- Brightness temperature
- Normalized radar cross section
- Sea surface salinity



http://nsidc.org/data/aq3_tb.html

http://nsidc.org/data/aq3_nracs.html

http://nsidc.org/data/aq3_sss.html

Relevant for studying:

- ice sheets
- sea ice
- frozen soil
- freshening

Brucker et al., 2014: Weekly gridded Aquarius L-band radiometer/scatterometer observations and salinity retrievals over the polar regions – Part 1 & 2, The Cryosphere.